UCRL-JC- 125188 abs

Adaptive Simultaneous Forward-Inverse Galerkin Method for Strongly Constrained Parameter Estimation

J P Ziagos [Environmental Restoration Division (ERD)], R. Gelinas (ERD), S. Doss (ERD) Lawrence Livermore National Laboratory (LLNL), Livermore, CA 94551; 510-422-5479. R. Nelson, PDE Solutions, Inc., Sunol, CA.

We attempt to solve the problem of calculating the hydraulic conductivity of a two-dimensional, steady-state, heterogeneous, porous media domain solely from the head measurements in the domain and fluxes on boundaries of the domain. The technique involves solving the flow equation simultaneously for the head (forward solution) and the conductivity (inverse solution). The numerical method employed uses a modified Galerkin, least-squares, adaptive gridding algorithm. The method has been verified on synthetic examples and applied to a field data set. Results highlighting the true effects of undersampling are presented. The algorithm determines a conductivity realization that honors the observed head and boundary flux data, is a solution to both the forward and inverse flow equations and provides an interpolation of both the head and conductivity within the domain that is consistent with the observations and meets the constraints of the differential equation. The technique has several novel features: it is a fully non-linear method that satisfies the forward and inverse differential equations for flow, is robust with respect to the initial conductivity estimate, interpolates both the observed head data and constitutive parameters with basis functions that are optimal solutions to the differential equations, and resolves highly disparate values of the heterogeneous conductivity variations that may physically occur in the domain.

Work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.